Effects of Selected Physical Traits on the Layout and Vertical Vaults of Women Intercollegiate Gymnasts

Karen Lee Schwan
EFFECTS OF SELECTED PHYSICAL TRAITS
ON THE LAYOUT AND VERTICAL VAULTS
OF WOMEN INTERCOLLEGIATE GYMNASTS

BY

KAREN LEE SCHWAN

A thesis submitted
in partial fulfillment of the requirements for the
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EFFECTS OF SELECTED PHYSICAL TRAITS
ON THE LAYOUT AND VERTICAL VAULTS
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This thesis is approved as a creditable and independent investiga-
tion by a candidate for the degree, Master of Science, and is accept-
able for meeting the thesis requirement for this degree. Acceptance of
this thesis does not imply that the conclusions reached by the candidate
are necessarily the conclusions of the major department.

Thesis Advisor

Head, Health, Physical Education and Recreation Department
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To the South Dakota State University Women's Gymnastic team and to Mike and Louise Keough, a sincere thanks for their assistance in the collecting of the data and testing of the competitors.

To my husband, Charlie, I wish to give full credit for this thesis. Without his moral support, encouragement and understanding, the opportunity to complete this study would have been impossible.

KIS
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CHAPTER I
INTRODUCTION

Significance of the Study

In recent years the quality of performance in side horse vaulting has improved substantially. This is due in part to its becoming one of the most exciting of the four basic events which comprise women's intercollegiate gymnastic contests. Recent improvements have also occurred as the result of an increase in the number of studies which have been conducted to determine proper techniques for the execution of this skill.

At present, an increasing number of coaches of gymnastics are giving greater attention to the development of a longer and more vertical preflight prior to contact with the horse. The importance of this aspect was supported in the findings of Guerrera, who found that those gymnasts with the best vaulting scores also executed the highest and longest preflights.1

The achievement of desirable vertical lift appears to be dependent upon the possession of certain physical traits. Based upon previous work in this area,2,3 it appeared that the traits of reaction-performance

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2Ibid.

time, static flexibility and power were those most likely to affect the quality of the prefight. The present researcher believed that an investigation into the influence of these traits on vaulting performance would be of value.

Statement of the Problem

The purpose of this study was to determine whether a relationship existed between reaction-performance time, static flexibility, power and vaulting scores earned by college and university women gymnasts in selected vaults during intercollegiate competition.

Hypotheses

1. There will be no significant relationship between scores achieved in measures of reaction-performance time, static flexibility, power, and scores received in competitive vaulting.

2. A multiple regression equation to significantly predict performance of gymnasts in competitive vaulting cannot be developed.

Limitations and Delimitations.

1. The subjects were women gymnasts who attained scores in the layout stoop and vertical vaults which qualified them for the Association of Intercollegiate Athletics for Women Regional Gymnastic Meet.

2. The selection of physical traits was limited to ankle flexibility, reaction-performance time and power.

3. The investigator made no attempt to control outside activities of the subjects.

4. All competitors were tested prior to regional competition.
5. Only regional competitive vault scores were used as the source of data.

6. Competitors scores were based on criteria of vaulting as established by the Federation of International Gymnastics code of points for women.

Definition of Terms

_Handspring Vault._ A handspring vault is a quick push vault in which the body passes through a vertical position, hands contact the horse giving forward-upward momentum and the body lands in an upright standing position.⁴

_Ankle Flexibility._ Ankle flexibility is the full range of motion in the ankle joint from maximum plantar flexion to maximum dorsal flexion in a degree of a circle.⁵

_Neutral Position._ Neutral position is the angle of 90° measured at the ankle joint when the joint is in neither plantar or dorsal flexion.⁶

_Reaction-Movement Time._ Reaction and movement time is the interval of time between the presentation of a stimulus, the initiation of


⁵Robert Carl Hoeg, "The Effects of Two Adhesive Ankle Taping Techniques upon Selected Motor Abilities and Ankle Flexibility" (unpublished Master's thesis, South Dakota State University, 1974) p. 3.

⁶Ibid., p. 4.
the response and reaction to the stimulus.  

Power. Power is the total amount of work accomplished in one unit of time.  

Block. The block is a step that reaches forward onto the reuther board with both feet keeping the center of gravity behind the ball of the feet. With the center of gravity behind the feet the body is redirected from a forward movement into a vertical movement.  


8John W. Northrip and others, Introduction to Biomechanics Analysis of Sport (Dubuque, Iowa: Wm. C. Brown Co. Publishers, 1981),  

9Bowers, op. cit., p. 201.
CHAPTER II

REVIEW OF RELATED LITERATURE

There is very little research literature available to which the coach or competitor can refer when attempting to improve vaulting performance. Due to lack of available quantitative information, authorities often propose different vaulting techniques. The need for more scientific study of vaulting has become apparent.

Literature for the current study was reviewed in two areas which included: Literature Related to Vaulting Research, and Literature Related to Physical Traits of Vaulters.

Literature Related to Vaulting Research

Authorities differ in their opinions about the execution of vertical vaults. Guerrera found a significant correlation with vault scores and higher and longer preflight in vertical vaults.1

An analysis of the criteria employed by judges was conducted by Nuzman who concluded that the correctness of the vault lies in the technique of the approach and the position of the board. Even though the run and the approach are not judged, they are imperative to a good vault. The "on board" position and the vertical lift are directly affected by the run and the approach.2


In a study of long horse vaulting for men, Guerrera reported that there were conflicting ideas about the execution of vertical vaults.³ His findings revealed that a smaller amount of time on the board facilitated a higher angle of take off. He also observed that the vaulters who spent less time contacting the board received higher scores.

Hay, who has researched the biomechanic actions of many sports, presented an analysis of the Biomechanics of Vaulting to the U.S. Gymnastics Federation.⁴ His analysis emphasized the need for a good block step onto the board. This was achieved by a hurdle step, which was a transition from the approach to the take off. The primary function of the Hurdle step is to position the body appropriately for the landing onto the board with a minimum loss in horizontal velocity.⁵

It is generally agreed that in any running jump the increase in vertical velocity necessary to gain height is accompanied by a decrease in horizontal velocity.⁶ Since vaulters need to maintain forward velocity, the hurdle step must be low and fast. The effect of the correctness of the hurdle and block position will facilitate a higher vertical lift.⁷

³Guerrera, loc. cit.
⁵Tbid.
⁷Hay, op. cit., p. 35.
Proper position, according to Carter, involves landing on the board on the ball of the foot. If the vaulter lands flat footed, the jump from the hurdle is delayed.  

Bowers was also supportive of this theory, as she observed that in order for a vaulter to get the most out of the board, the vaulter must land with weight on the ball of the foot and leave the board with a quick ankle push.

Literature Related to the Physical Traits of Vaulting

**Flexibility.** Flexibility of a joint affects the forces a muscle can exert and consequently influences motor performance. By increasing the range of motion, a performer can exert forces over greater distances and time. The velocities, energies and momenta associated with performance are also increased as the range of motion is increased.

devVries states that there are limits of flexibility for each individual. Therefore, the static flexibility that can be achieved by each person is controlled by three physiological limitations: (1) muscle and its fascial sheaths; (2) connective tissue; and (3) the skin.

**Power.** Power, as defined by Northrip, is the product of force

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times velocity. Power plays a prominent role in the performance of a broad array of sport skills. As the vaulter approaches the board, there is a reduction of speed in order for maximum force for vertical lift to be developed. In order to compensate for this reduction of speed, a greater range of motion can be used. The importance of this has been observed in the approach to the hurdle step, as well as the take off.

According to Hay, in the approach the vaulter tries to get to the optimum point of take off into the hurdle step with as much horizontal momentum as possible. During the hurdle step the vaulter adjusts the body position to facilitate the execution of an optimal take off. Also, in the take off phase, which he regards as the most critical phase of the vault, the gymnast attempts to obtain the momentum necessary to achieve optimum angular momentum required for the vault.

Reaction-Performance Time. Reaction-performance time is the interval of time between the presentation of the stimulus, the initiation of the response, and the reaction to the stimulus.

As investigated by Guerrera, those vaulters who spent less time on the board had consistently higher scores.

In a study by Lotter, it was found that reaction time in the legs
is significantly slower than in the arms. By testing the legs separately and paired, it was found that the reaction time was better in the paired legs. It was also concluded that quickness of reaction and quickness of movement are unrelated.\textsuperscript{17} Johnson, however, has reported that practice and training in a game-like situation would improve reaction time abilities.\textsuperscript{18}

**Summary of Review of Literature**

In reviewing the literature, it was discovered that a quality vault is influenced by adherence to certain principles which must be followed if a higher preflight is to be achieved. These include:

1. change of momentum from horizontal to vertical;
2. change in the length of the body radius;
3. reaction time.

\textsuperscript{17} William S. Lotter, "Interrelationships among Reaction Times and Speed of Movement in Different Limbs," Research Quarterly, May, 1960, pp. 147-155.

\textsuperscript{18} Johnson and Nelson, op. cit., p. 230.
CHAPTER III

METHODS AND PROCEDURES

The purpose of this study was to determine whether a relationship exists between static flexibility, reaction and performance time, power, and vaulting scores earned by college and university women gymnasts in selected vaults during intercollegiate competition.

Organization of the Study

The study was conducted during the competitive women's gymnastic season for the Association of Intercollegiate Athletics for Women. A battery of three tests was administered at the Regional Women's Gymnastic Meet held at Ames, Iowa on March 13 and 14. Tests for reaction time, power and static flexibility were given on March 13, 1975. The tests were administered by the investigator and two trained assistant testers. The assistant testers were trained for two days prior to actual test administration.

A letter describing the purpose of the study and requesting cooperation was sent to fourteen colleges and universities whose previous meet scores indicated to the investigator that requirements would be met for participation in the Region VI Women's Gymnastics Meet. The letter was accompanied by a return-addressed, postage paid card.

Those schools that wished to participate in the study returned the card with the name of the institution, the coach's name, the names of the qualified vaulters, and the type of vault that each vaulter would perform on the first and second attempt in the Regional Meet. A space
was provided for the coach to indicate preference to receive a copy of the results. Explanatory letter and return card appear in Appendix B.

Ten of the fourteen schools replied. Eight of the ten planned to attend the Regional Women's Gymnastics Meet in Ames, Iowa. Upon arriving at the Region VI Meet, a previously nonresponding coach asked that his vaulters be included as subjects in the study. As a result, vaulters from nine colleges and universities were used as subjects.

Coaches expressed concern about the amount of time involved in the testing procedures. The investigator informed all coaches of testing plans which were agreed upon by all coaches.

**Source of the Data**

Subjects for the study were thirty-five women gymnasts in Region VI who competed in vaulting during the intercollegiate competitive season and scored a minimum of 6.5 in a layout stoop vault or a vertical vault. This procedure was used to establish a homogeneous group for testing purposes. The group ranged in age from 19 to 21 years. The groups ranged in weight from 104 to 158 pounds; the average weight of the group being 123 pounds or 55.79 kilograms. A pilot study was conducted for the purpose of determining accuracy and administrative feasibility of the tests.

After completion of the data collection at the Region VI Women's Gymnastics Meet, a learning effect could be seen in the results of data collected from competitors of South Dakota State University women gymnasts. These subjects were eliminated from the test to insure accuracy of the data during statistical analysis. As a result, the data from testing
twenty-nine subjects was used for analysis.

The learning effect was supportive of the study by Johnson in which he stated that practice and training on a gamelike situation would improve reaction time abilities.¹ Since the South Dakota State University gymnasts were involved in the pilot study, they were aware of the investigator's intended use of the scores.

Collection of the Data

Each team consisted of a maximum of six competitors. Each performer was given the Nelson Reaction Time Test for the lower extremities, the Jump and Reach Test for leg power and each was measured for dorsal and plantar ankle flexion. Three to five minutes was necessary for each competitor to complete the test battery and twenty to thirty minutes for each team, depending on the number of team members. The competitors were tested during the team's practice workout session which was scheduled by tournament officials. Practice times ranged from 10:00 AM - 4:00 PM. The coaches emphasized the need for expediency in testing in order to have adequate warm-up time; therefore, the investigator set up four stations for testing purposes. Each competitor was weighed first and the weight was recorded to the nearest one-half pound. The competitor then went to the Jump and Reach Test or the Reaction Time Test. After completion of one of these tests, the competitor reported to the Static Flexibility station. After completing the Static Flexibility Test, they

returned to be tested in the Jump and Reach or the Reaction Time Test. This testing procedure was employed in order to save time for the completion of the test battery.

To facilitate the testing of competitors, the present writer selected the following tests because of ease of administration and no requirement for expensive, elaborate or bulky equipment to transport.

**Reaction-Performance Time Test.** Reaction time for the lower extremities was measured by the Nelson Reaction Time Test. The test for lower extremities was chosen over the hand reaction test because reaction time in the legs is significantly slower than reaction time in the arms.²

This test was used to measure reaction-performance time of the feet and to determine if a relationship exists between reaction time and a competitor's vault score. Reliability of this test was .85 with college men as subjects. Face validity was accepted.³

Measurement for the Nelson reaction time test was taken with the competitor seated on a table one inch from the wall. The competitor positioned the foot so that the ball of the right foot was held one inch from the wall while the heel rested on a marked line two inches from the wall. The distance was prominently marked so that each competitor started from the same position. The assistant evaluator held a Nelson Reaction Time Test stick next to the wall so that the baseline of the stick


³Johnson and Nelson, op. cit., p. 230.
was directly across from the upper end of the big toe. Each competitor was told to focus on the concentration zone and to react when the stick was dropped by pressing the stick against the wall with the ball of the foot. This process continued until the subject had completed five trials with each foot. The two fastest times for each foot were averaged and combined resulting in an overall reaction time which was recorded.

Jump and Reach Test. Power of the legs was measured by the Jump and Reach test to determine whether a relationship might have existed between power and the vault score. The Lewis Nomogram was employed so that the body weight of each individual would be considered in this calculation.

The wall was marked by two yard sticks, twelve inches apart, and 6'4" from the floor. Between the yardsticks were three sheets of construction paper which rose to a height of 9'4".

The competitor chalked her fingertips and stood sideways to the wall. Keeping the heels on the floor, the competitor stretched her arm up to the paper and touched it, giving the evaluator the standing reach of the competitor. Beginning in a crouched position, the competitor jumped and touched the paper with her fingertips at the highest point. Three trials were given. Each trial was measured by placing a ruler across the paper on top of both yardsticks with each end of the ruler

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4 Ibid.


6 Ibid.
in the same position on the yardstick. The top of the fingertip was measured to the nearest one-fourth inch for test purposes. The best of the three trial measurements was subtracted from the standing reach measurement for the final score. The competitors' weight was converted into kilograms and the inches scored on the test were converted into meters. Using a straight edge on the Lewis Nomogram to connect the kilograms of weight with the meters jumped, a final measurement was expressed in kilograms per meter per second.

**Flexibility Test.** Static flexibility was measured to determine the complete range of motion in the ankles of each vaulter. As previously stated by Northrip, the flexibility of a joint affects the forces a muscle can exert and consequently influences motor performance.⁷ By increasing the range of motion, a performer can exert forces over greater distances and time.⁸

During this test, the competitor sat on a table with the leg of the foot to be measured straight and the other leg bent. The ankle of the foot to be measured was positioned to touch a board that rose two feet above the table. A large sheet of construction paper (16 X 24) was taped to the board on which degrees of plantar and dorsal flexion were recorded by creating a shadow of the foot on the paper with a slide projector. A yard stick was used to position the heel of each competitor in line with the light of the projector. This provided for the same size

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⁸Ibid.
shadow for each competitor. The heel of the foot was marked and designated as the base for a vertical line for plantar and dorsal flexion. The subject plantar flexed and the investigator marked the top of the shadow of the big toe. The same procedure was followed with dorsal flexion. The dorsal and plantar flexion marks were connected by a straight ruler line to the vertical point. A protractor was used to measure the angles of degrees for plantar and dorsal flexion positions. The angles of degrees were added to determine the full range of motion of each ankle. The scores of each foot were averaged for the final angle of degrees. The test used to measure static flexibility was devised by a South Dakota State University male gymnast majoring in engineering. Illustrations for testing procedures appear in Figures 1, 2, and 3.

**Pilot Study Data.** A pilot study was conducted involving seven South Dakota State University women gymnastic team members. The tests were administered on March 3, 1975, March 5, 1975 and March 7, 1975. The investigator's measuring techniques were checked on March 3 by the Research Coordinator at South Dakota State University and it was suggested that the subjects be tested in a quieter atmosphere. Also, the time limit for the reaction time test was changed from five seconds to three seconds to accommodate better concentration for the subjects. The tester counted one-thousand-one, one-thousand-two, one-thousand-three and without obvious finger movement, released the stick. The testing procedures were checked March 5, 1975 by the Research Advisor and the Graduate Advisor and approved. All the subjects for the pilot study were tested by the investigator.
Figure 1
Recording for Static Flexibility

Figure 2
Recording for Power

Figure 2
Recording for Reaction-Performance Time
The pilot study was used to show the reliability of the test battery. Raw data appears in Appendix A.

The scores of the vaults performed by each competitor and the results achieved in the evaluation of physical traits formed the basis for testing the hypotheses.
CHAPTER IV

ANALYSIS AND DISCUSSION OF RESULTS

Organization and Analysis of the Data

The investigator identified three independent variables as being possible contributors to better vaulting scores in women's intercollegiate gymnastics. The independent variables measured were chosen because of their possible contribution as physical traits necessary for good vaulters. Included were the components of reaction and performance time, static ankle flexibility, and power. The dependent variable investigated was the competitors' vault score. The means and standard deviations for the three independent variables, the dependent variable, and the order of entry in the regression equation are presented in Table I. The raw data is shown in Appendix A.

In order to predict the competitors' vault score on the basis of three selected variables, a multiple regression statistical procedure was used to analyze the data.\(^1\) The first step in this procedure was to compute the intercorrelations of each independent variable and the correlations between the independent and dependent variables. The multiple regression equations were then developed, beginning with a one variable equation and adding one additional variable in each of the following steps to increase the accuracy of the predictions. A standard

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TABLE I

MEANS AND STANDARD DEVIATIONS AND ORDER OF ENTRY 
OF THE SELECTED VARIABLES

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Variance Explained</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X^1$ Reaction Time</td>
<td>18.14819</td>
<td>2.10061</td>
<td>1.973</td>
<td>.071</td>
</tr>
<tr>
<td>$X^2$ Jump and Reach</td>
<td>80.86201</td>
<td>8.36115</td>
<td>1.603</td>
<td>.058</td>
</tr>
<tr>
<td>$X^3$ Static Ankle Flexibility</td>
<td>94.74138</td>
<td>12.82688</td>
<td>.133</td>
<td>.005</td>
</tr>
<tr>
<td>$Y_1$ Vault Score</td>
<td>7.62241</td>
<td>.99665</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Variance of $Y$ 27.813
error of the estimate, multiple correlation coefficient and variance accounted for in that step were also computed for each step in the equation. The .05 level of confidence was accepted as being the minimal level needed for a coefficient to be considered significant. An electronic computer was used to increase the speed and accuracy of the statistical procedure.

**Correlation analysis.** Table II shows the Matrix of simple order correlations. One of the correlations (reaction time and flexibility, -.406) was significant at or beyond the .05 level of confidence. A critical sum of the squares of 4.278 was necessary to be significant in any single step. The overall prediction equation, even though not significant, was \( Y = 11.8158 - .1345 \text{ reaction-performance time} - .02858 \text{ jump and reach } + .0059 \text{ flexibility} \).

**Analysis of the Regression Equation.** The regression equation developed in the present investigation is shown in Table III. Reaction-performance time, although not significant, had a sum of squares coefficient of 1.97, which was the highest correlation of the three variables. The total variance for \( Y \) was 27.813 found in the variables. Of this, only 13.3% could be accounted for. The reaction-performance time accounted for 7.1% of the variance in the variables. A sum of squares coefficient of 1.603 was found for the jump and reach test. This accounted for 5.8% of variance in the variables. The least significant of the three variables was the flexibility test. The sum of squares coefficient was .133 which accounted for only .5% of the variance in the variables.

**Discussion of the Results**

Although this analysis of the variables revealed little
#### TABLE II

**CORRELATION MATRIX**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.00</td>
<td>-0.26631</td>
<td>-0.19176</td>
<td>0.18786</td>
</tr>
<tr>
<td>2</td>
<td>1.00000</td>
<td>-0.20071</td>
<td></td>
<td>-0.40664</td>
</tr>
<tr>
<td>3</td>
<td>1.00000</td>
<td></td>
<td>0.01414</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.00000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Row 1 - Vault score  
2 - Reaction time  
3 - Jump and reach  
4 - Static ankle flexibility

\[ r = 0.367 \]
## TABLE III

REGRESSION EQUATIONS DEVELOPED TO PREDICT VAULT SCORES

<table>
<thead>
<tr>
<th>Regression Equation</th>
<th>Standard Error of Estimate</th>
<th>Multiple Correlation</th>
<th>Variance Accounted*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ( Y_1 = -0.13x_1 + 9.92 )</td>
<td>.98</td>
<td>.071</td>
<td>1.97</td>
</tr>
<tr>
<td>2. ( Y_1 = -0.15x_1 - 0.03x_2 + 12.70 )</td>
<td>.96</td>
<td>.058</td>
<td>1.603</td>
</tr>
<tr>
<td>3. ( Y_1 = -0.13x_1 - 0.3x_2 - 0.01x_3 + 11.82 )</td>
<td>.98</td>
<td>.005</td>
<td>.133</td>
</tr>
</tbody>
</table>

* Total Variance = 27.813
MS Variance = 1.00433
F.05 (1/24) = 4.26
Minimum Variance Needed to Contribute Significantly to the Equation = 4.26 x 1.00433 = 4.27845
significance between the independent variables and the vault score, the present investigator believed that with some adjustments in the procedure, a higher correlation might be observed. In view of the fact that the group selected was highly homogeneous, the findings which revealed a limited range of variability, was to be expected. A wider range of age and ability of competitors would have provided for additional variability. The required score of 6.5, which was the criteria established to qualify competitors as subjects in the present study, added to this small degree of variability.

It appeared likely that consideration of a larger number of variables would improve accuracy in predictability. For example, the parameters of height, speed of approach, weight and dynamic flexibility may also be important components related to the act of vaulting.

Results for power and static flexibility would seem to indicate that the characteristics to be tested in the present investigation were not properly measured. This is not to imply that the tests for these traits were inadequate, but that these characteristics should not be measured in isolation. Measured separately, these traits are not as essential to success in the act of vaulting as a combination of them, which may be defined as dynamic flexibility. The measurement of this trait would determine the velocity and level of force which can be observed in an ankle moving through the range of motion. A review of the literature, however, did not reveal that an instrument capable of

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measuring this trait was available. Guerrera alluded to the value of this trait when describing the concept of reducing the amount of time spent on the board and referred to as explosive power from the ankles.\(^3\) Also supportive of the use of quick ankle push was Bowers who stated that this trait is necessary in order to get the most action from the board.\(^4\) As reported by Guerrera, those who spent less time on the board had the highest scores in competitive vaulting. This was observed in reuther board times for male long horse vaulters. A vaulter with a score of 9.8 was on the board for .30 of a second while a vaulter with a score of 8.5 was on the board for .45 of a second.\(^5\) Although his study did not include reaction-performance time as a variable, Guerrera timed the entire vaulting procedure so that he could quantify the time spent on the reuther board by each vaulter.

Since the independent variables measured in the present investigation did not demonstrate a significant correlation with scores achieved in competitive vaulting, the present researcher failed to reject the hypothesis that there will be no significant relationship between scores achieved in measures of reaction-performance time, static flexibility, power and scores received in competitive vaulting.

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\(^5\)Guerrera, loc. cit.
The second hypothesis stated that a multiple regression equation to significantly predict performance of gymnasts in competitive vaulting cannot be developed. Since none of the computed F-ratios accounted for were significant at the .05 level of confidence, it was also necessary for the present researcher to fail to reject this hypothesis.
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to determine whether a relationship existed between reaction-performance time, static flexibility, power, and vaulting scores earned by college and university gymnasts in selected vaults during intercollegiate competition.

Twenty-nine women gymnasts who competed during the 1974-1975 gymnastic season were the source of the data. The independent variables analyzed were reaction-performance time, static flexibility, and power. From intercorrelations between these independent variables and their correlation with the vault scores as the dependent variable, regression equations were developed for the purpose of predicting competitive vaulting scores.

The results of this study revealed that none of the variables related significantly to the vault score. Although none of the variables were significant, reaction-performance time appeared to have the highest relationship of the three.

Conclusions

Within the limits of this study, the following conclusions seemed warranted.

1. Competitors' vaulting scores cannot be predicted based upon measures of reaction-performance time, ankle flexibility, or power.

2. A multiple regression equation to accurately predict
performance of gymnasts in competitive vaulting based on the selected measures of reaction-performance times, static flexibility and power cannot be developed.

**Recommendations:**

Based on the findings of this study, the investigator proposes the following recommendations for further study.

1. That a similar study be conducted analyzing a more heterogeneous group of gymnasts.
2. That a similar study be conducted using more variables.
3. That a similar study be conducted using dynamic flexibility as a variable.
BIBLIOGRAPHY

A. BOOKS


B. PERIODICALS


C. UNPUBLISHED MATERIAL


<p>| | | |</p>
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**APPENDICES**
## APPENDIX A

### RAW DATA OF COMPETITORS

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<tr>
<th>No. of Competitor</th>
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<th>R-P* Time</th>
<th>Jump &amp;** Reach</th>
<th>Static*** Flexibility</th>
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### APPENDIX A (Continued)

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* Seconds  
** Kg-m/sec  
*** Degrees
APPENDIX B

LETTER REQUESTING COOPERATION OF COACHES OF TEAMS
ENTERED IN REGION VI A.I.A.W. WOMEN'S GYMNASTIC MEET

Dear Coach,

As part of a graduate research investigation, I am attempting to determine whether certain physical characteristics of gymnasts can be used to predict performance in vaulting.

In order to have a group of subjects that are similar in ability, I would like to administer three simple tests to as many women vaulters at the Women's Regional Meet as possible. The tests will require almost no expenditure of energy and are not hazardous.

The three tests include: (1) Nelson's Reaction Time Test for the feet; (2) Jump and Reach Test; and (3) Static Flexibility Test for the ankles.

If you would be willing to allow your gymnasts to participate in my testing program, I would appreciate your completing the enclosed card and returning it to me as soon as possible.

I have explained how this study might be of value to coaches of gymnastics to Lois Mussett (A.I.A.W. Chairwoman, Region VI). She has agreed that this investigation has merit and she hopes that coaches whose teams are participating in the vaulting event at the Regional Meet will cooperate.

A copy of the results of this study will be available. If you would like to receive a copy, please check the appropriate space provided on the enclosed card.

Sincerely,

Mrs. Karen L. Schwan
Department of Health, Physical Education and Recreation

This thesis study has been approved by the Health, Physical Education and Recreation Department at South Dakota State University. I would appreciate any assistance you can give Mrs. Schwan.

Dr. Neil Hattlestad
Coordinator of Graduate Research
APPENDIX B (Continued)

DATA COLLECTION CARD

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Yes, I would like a copy of the results of this investigation.